Machine R&D for RSVP (Ahrens 21Oct 04)

Overview - topics:

List of experimental needs

What efforts are required?

Three steps:

1) Reestablish high intensity and improve

2) Extraction developments at low intensity

3) Extraction developments at high intensity

1) and 2) in parallel, and both mature before go to 3)

A Crude Schedule for the Work

Experimental Needs:

MECO:

intensity:

40Tp/sec @8GeV

e.g. 40Tp/AGS cycle, 1 sec cycle

extraction:

8 GeV microbunching 1.35us bunch spacing

total effective protons:

4×10^{20}

KOPIO:

intensity:

20Tp/sec @24GeV

e.g. 100Tp/AGS cycle, 5 sec cycle

extraction:

24 GeV minibunching 40ns bunch spacing

total effective protons:

9×10^{20}

HISTORY

intensity:

15Tp/sec @ 24GeV

total protons:

7×10^{20} in Booster era ($\sim 7 \times 10^{20}$ in preBooster era)

Plan step 1:

Intensity:

15Tp/sec (24 GeV) in 2002
need to grow to
20Tp/sec for KOPIO (25.5 GeV)
40 Tp/sec for MECO (8 GeV)

total protons:
need 2x what has been done post-Booster
(and probably twice this before done)

a) increase the peak AGS intensity (77Tp -> 100Tp) and recover peak Booster intensity (>20Tp)

KOPIO: better matching at AGS transfer (stronger kicker). How much does this gain us? (15Tp/sec -> 20Tp/sec)

MECO: needs the 20Tp/transfer. Is this a hard max limit or an activation issue?

b) reduce or better control the losses

Historic: BtA efficiency and "ALARA" Limits constrain max output to about 14 Tp/sec for MECO setup.

MECO plan: Requiring only two transfers, and taking advantage of relaxed constraints dp/p limit (ordinarily required to get through transition), improve this efficiency. How much does this gain us?

if BtA eff 70% -> 90%, BtA would allow 40Tp/sec.

However (historic) Booster losses and limits then only allow 19Tp/sec (Boo acceleration) and 22Tp/sec (Boo injection).

Probably can accelerate 40Tp/sec (20Tp/Booster cycle) but cannot tolerate the losses.

Reduce/control losses at injection (foil thickness, graphite shielding)

Control losses during acceleration (collect losses in the internal "dump" - scraper, and reduce countable losses proportionally).

Some tasks:

Revisit the high intensity potential in the Booster

Does the answer depend on the accelerating harmonic? (memory: yes, "data" no.)

Commission the RF hardware/controls

new gear since the last high intensity run (E949, spring of ’02)

Cope with planned dumping of this beam

Booster (and then AGS) Internal dumps

Very low duty cycle (ok - that is the plan)

Dump must survive single bunch high intensity "shock"

AGS External dump

This facility should be refined in step with the intensity increases. (This should become MECO extraction - i.e. below transition from AGS).

Plan Step 2:

Understand the desired Slow Extraction setups at low intensity.

simpler, cleaner situation than at high intensity and relevant

Both extraction schemes have been demonstrated at the AGS using available hardware and yielding reasonable bunch characteristics.

Neither setup was the final answer.

"Extinction" of extracted beam between the desired bunches needs work.

Paths to achieving requirements are clear.

More conventional spill quality issues – intensity modulation on slower time scales

New spill quality issues - undesired intensity modulation at the revolution period time scales

a) **MECO**: the basic bunching hardware is ready– (slow extraction below transition); vertical extraction aperture question. A preliminary version of the gap cleaning hardware exists for study.

b) **KOPIO**: the bunching setup will lack the final hardware for several years. The intent of the R&D is to obtain very good agreement between simulations and the results measured with beam using available hardware (i.e. RF cavities). The extraction beam properties to be understood are: bunch width, “extinction”, and the beam not extracted.

c) **MECO slow extraction** would become the desirable way to cope with high intensity beam dumping in the near future.

Plan step 3:

Understand the desired Slow Extraction setups at high beam intensity.

a) conventional slow extraction quality degrades as intensity increases (spill structure). Understand the magnitude of the effects– at least enough to cope. The problems may be quite different for the two extraction energies.

b) the amount of beam in the gaps will probably increase with intensity – for both setups. Measure and figure out how to fix. (machine impedance, allowed dp/p).

Understand any constraints associated with achieving highest intensity acceleration while working behind RHIC.

R&D / Commissioning Schedule

(this planning assumes "base" funding starting in FY 2006 and an engineering run in FY 2010)

year 1	low intensity , high intensity	
('06)	(very low duty cycle)	
		bunched extraction
		8 GeV extraction
		Coexist with RHIC
year 2	high intensity Booster, AGS	
('07)	(very low duty cycle)	
		8 GeV extraction
		bunched extraction
year 3	high intensity	
('08)		
		intensity effects
year 4	high intensity	
('09)	new equipment:	AGS injection kicker
		KOPIO 25 MHz cavity
year 5	physics experiments engineering run	

This table has not been revisited yet for November review

The final table from AGS commissioning plan (the plan is listed on the web at the site for this review) (not yet) giving the yearly bottom line time requirements from this planning:

Fiscal Year	'06	'07	'08	'09
	sessions	sessions	sessions	sessions
basic setup		9	10	10
intensity	13	12	10	10
MECO, low intensity work	17	3	0	0
MECO, high intensity work	0	0	3	5
KOPIO, low intensity work	0	3	0	7
KOPIO, high intensity work	0	0	3	5
total sessions	30	27	26	37
	days	days	days	days
required calendar days	60	54	52	74
with high intensity penalty	60	54	60	84
	days	days	days	days
potential unused (between sessions) time	30	27	26	37

Roughly 8 weeks of work each year.